# Personal Statement

"Everyone picks the fastest route—and yet, every road jams up." An offhand remark from a taxi driver during a field survey sparked my deeper reflection: why do rational individual choices so often produce such inefficient collective outcomes? Is urban traffic inevitably a *prisoner's dilemma*? Or could we, through information sharing and behavioural guidance, steer the system toward cooperative optimisation? As the *Braess Paradox* illustrates, building new roads does not necessarily improve traffic flow; it can even destabilize the entire system. I came to realise that the true remedy for urban congestion lies not in passively "building more roads," but in actively "orchestrating the flow"—leveraging intelligent, data-driven mechanisms to foster coordination among individual decisions, thereby unleashing the latent efficiency of the traffic network. This shift in perspective led me to move beyond the boundaries of my major in engineering management and, since my sophomore year, to delve deeply into the study of intelligent transportation under the guidance of Professor Xia Xinhai.

To put this understanding into practice, I led a traffic investigation in downtown Kaiping during the summer of my sophomore year. Together with my team, we collected comprehensive data on traffic flow and parking conditions through drone photography, on-site surveys, and interviews. The findings were striking: underground parking lots had an average vacancy rate exceeding 30%, while illegal on-street parking remained rampant. The result? Disordered traffic and a frustrating daily commute for local residents. To address this resource mismatch, I set out to develop a parking guidance model grounded in historical spatiotemporal data. By dynamically predicting demand, the model helped reroute vehicles toward underutilized spaces, improving overall efficiency. I handled data cleaning, statistical modelling, and simulation validation independently using Python and SPSS, and authored the final report. Our recommendations were subsequently adopted by the municipal transportation bureau. This experience reinforced a critical insight: smart transportation is not about technological novelty for its own sake—it's ultimately about enabling people-centred, fine-grained urban governance.

A similarly formative experience came during the 2025 *Interdisciplinary Contest in Modeling* (ICM), where I analysed the collapse of the Francis Scott Key Bridge in Baltimore. After a container ship struck a pier, the bridge gave way within seconds, severing a vital artery used by over 34,000 vehicles daily. Traffic was abruptly diverted, nearby roads were overwhelmed, and the urban network descended into cascading failure. The incident left me questioning: is the goal of intelligent transportation systems merely to optimise routine flow? Surely not. A truly resilient system must also withstand extreme disruptions—an idea that echoes the systemic risk control principles I studied in engineering management. Where Kaiping revealed constraints in street-level governance, Baltimore laid bare the vulnerabilities of city-scale control. Together, these two cases pointed to a shared conclusion: the need for a biomimetic *dual-loop* traffic architecture. Its outer loop, like an immune system, would enable rapid response and self-repair during crises; its inner loop, akin to metabolic regulation, would continuously adapt and evolve to sustain daily operations. This ecological perspective has since anchored my approach to future urban mobility, where efficiency, stability, and equity coexist in harmony.

During my third-year winter break, I sought to apply the *flow orchestration* principle to a full-scale urban road network through the Guangdong Undergraduate Innovation and Entrepreneurship Programme. Yet I soon ran into a more entrenched obstacle: severe data incompleteness. Loop detectors failed, floating car data was sparse, and drone imagery came in fragments, both spatially and temporally. The result? High-dimensional traffic tensors, riddled with irregular gaps, rendered model deployment and policy validation nearly impossible. To tackle this, I taught myself tensor theory, reviewed a large body of literature, and eventually developed a low-rank tensor completion model based on the *Adaptive Truncated Schatten Norm* (LRTC-ATSN), which overcame the limitations of traditional nuclear norm approaches and more flexibly handled complex, non-random missing patterns. Tested on real-world datasets from Guangzhou and Seattle, it achieved a 10.6% and 6.1% reduction in MAPE and RMSE respectively—under conditions with up to 95.85% missing data—while accelerating convergence by more than 20% compared to the best-performing baseline. As first author, I presented this work at the 25th COTA International Conference of Transportation Professionals, where I actively engaged with attendees and received the Best Poster Award. The project left me with more than a technical milestone: it reaffirmed that data is the bedrock of intelligent transportation, and honed my end-to-end research capabilities—from problem formulation to algorithmic execution.

With a solid data foundation in place, I naturally extended my research into intelligent control and system-level optimisation—specifically, how to construct a closed-loop framework linking micro-level interventions with macro-level feedback. I began at the intersection level, where I developed a queueing model based on *Markov processes* and proposed a dynamic signal timing strategy that significantly improved throughput. Later, during an internship at Xueshujia Technologies in Guangzhou, I contributed to deploying *multi-agent reinforcement learning* (MARL) frameworks for vehicle–infrastructure cooperative control, focusing on dissipating highway shockwaves. In parallel, I worked with my mentor to explore theoretical pathways in *sparse stochastic optimal control*, deepening my understanding of robustness in complex dynamic systems. These cumulative experiences—both practical and theoretical—gradually led me toward more holistic system regulation. Currently, I am engaged in *dynamic traffic assignment* (DTA) modelling for mixed traffic flows, aiming to capture the nonlinear evolution of urban mobility dynamics and to develop adaptive, cooperative control architectures that integrate efficiency, stability, and equity in next-generation intelligent transportation systems.

My research vision is clear, but I've found that true impact in urban mobility demands more than just ideas—it requires the right academic platform and resources to bring them to life. I'm keen to join a vibrant community where I can actively reconfigure the "human–vehicle–road–environment" relationship using data-driven intelligent control. I'm eager to contribute my skills in system design and algorithmic thinking, while also learning and growing through mentorship and collaborative research. What truly drives me is the chance to engage with the complex challenges of next-generation mobility, tackling them from both theoretical and experimental angles. My ultimate goal is to build systems that aren't just efficient and scalable, but also equitable and human-centered. I am confident that the right research environment will amplify these efforts, and I welcome connections with anyone who shares a passion for reimagining the future of transportation.